REMARKS/ARGUMENTS

Claims 23-28, 30, 31, and 33-57 are pending in this application. By this Amendment, Applicant AMENDS the specification and Claims 31, 33 and 34 and CANCELS Claim 32.

Paragraph [0026] of the specification and Claims 31 and 33 have been amended to recite H/λ instead of H in the equations contained therein to clarify that the normalized electrode thickness is being described and claimed. Support for this feature is found in Figs. 7 and 8 which show the electrode thickness as being defined as H/λ. In addition, Claim 31 has been amended to recite the feature of "$\rho > 3,745$ kg/m^3." Support for this feature is found, for example, in Applicant's originally filed Claim 32.

In addition, Claims 31 and 34 have been amended to recite "properties of the boundary acoustic wave device are not changed by changes in surface conditions of the single crystal substrate and the solid layer." Support for this feature is found, for example, in paragraph [0006] of Applicant's substitute specification.

Claims 23-28, 31, 33, and 35 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. (US 2002/0158549) in view of Taniguchi (U.S. 2001/0008387) and Takayama et al. (U.S. 2004/0174233). Claim 30 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., and Takamine (U.S. 2002/0135267). Claim 34, 43-48, and 50 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., and Nakahata et al. (U.S. 6,025,636). Claims 32, 36-38, and 41 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., and Nishiyama et al. (U.S. 2007/0132339). Claims 39 and 40 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., Nishiyama et al., and Mishima et al. (U.S. 2005/0099091). Claim 42 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., and Kadota et al. (U.S. 5,260,913). Claim 49 was rejected under 35 U.S.C. § 103(a) as being

unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., Nakahata et al., and Takamine. Claims 51-53 and 56 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., Nakahata et al., and Nishiyama et al. Claims 54 and 55 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., Nakahata et al., and Nishiyama et al., and Mishima et al. Claim 57 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi, Takayama et al., Nakahata et al., Nishiyama et al., and Kadota et al. Applicant respectfully traverses the rejections of claims 23-28, 30, 31, and 33-57.

Claim 31 has been amended to recite:

> **A boundary acoustic wave device using a non-leaky propagation type boundary acoustic wave**, comprising:
> **a plurality of boundary acoustic wave elements, each boundary acoustic wave element including a single crystal substrate, a solid layer provided on the single crystal substrate, and electrodes arranged at a boundary between the single crystal substrate and the solid layer**; wherein
> the single crystal substrates have a same cut angle;
> a propagation direction of a boundary acoustic wave of at least one of the boundary acoustic wave elements is different from that of at least one of the other boundary acoustic wave elements;
> **properties of the boundary acoustic wave device are not changed by changes in surface conditions of the single crystal substrate and the solid layer;**
> **a thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate;**
> **$H/\lambda > 8261.744\rho^{-1.376}$, when ρ (kg/m^3) represents the density of the electrodes, H represents the thickness of the electrodes, and λ represents the wavelength of a boundary wave; and**
> **$\rho > 3,745$ kg/m^3.** (emphasis added)

Claim 34 has been amended to recite:

A boundary acoustic wave device using a non-leaky propagation type boundary acoustic wave, comprising:

a plurality of boundary acoustic wave elements, each boundary acoustic wave element including a single crystal substrate, a solid layer provided on the single crystal substrate, and electrodes arranged at a boundary between the single crystal substrate and the solid layer; wherein

the single crystal substrates have a same cut angle;

a propagation direction of a boundary acoustic wave of at least one of the boundary acoustic wave elements is different from that of at least one of the other boundary acoustic wave elements;

properties of the boundary acoustic wave device are not changed by changes in surface conditions of the single crystal substrate and the solid layer;

a thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate; and

the piezoelectric single crystal substrate is a LiNbO₃ substrate, φ of Euler angles (φ, θ, ψ) of the LiNbO₃ substrate is in the range of -31° to 31°, and θ and ψ are in the range surrounded by points A1 to A13 shown in the following Table 1:

Table 1

Points	ψ (°)	θ (°)
A01	0	116
A02	11	118
A03	20	123
A04	25	127
A05	33	140
A06	60	140
A07	65	132
A08	54	112
A09	48	90
A10	43	87
A11	24	90
A12	0	91
A13	0	116

. (emphasis added)

The Examiner alleged that the combination of Itakura et al., Taniguchi, and Takayama et al. teaches all of the features recited in Applicant's Claim 31, and that the combination of Itakura et al., Taniguchi, Takayama et al., and Nakahata teaches all of the features recited in Applicant's Claim 34. The Examiner acknowledged that neither Itakura et al. nor Taniguchi teaches or suggests that the thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate. The Examiner alleged that Takayama et al. teaches this feature. Thus, the Examiner concluded that it would have been obvious "to combine the electrode thickness of Takayama et al. with the boundary acoustic wave device of Itakura et al. as modified by Taniguchi for the benefit of reducing the propagation loss." Applicant respectfully disagrees.

Contrary to the Examiner's allegations, none of Itakura et al., Taniguchi, Takayama et al., and Nakahata et al. teaches or suggests any boundary acoustic wave devices whatsoever, or the feature of properties of the boundary acoustic wave device are not changed by changes in surface conditions of the single crystal substrate and the solid layer. To the contrary, each of Itakura et al., Taniguchi, Takayama et al., and Nakahata et al. discloses **only** surface acoustic wave devices. Thus, Itakura et al., Taniguchi, Takayama et al., and Nakahata et al. clearly fail to teach or suggest the features of "a plurality of boundary acoustic wave elements, each boundary acoustic wave element including a single crystal substrate, a solid layer provided on the single crystal substrate, and electrodes arranged at a boundary between the single crystal substrate and the solid layer" and "properties of the boundary acoustic wave device are not changed by changes in surface conditions of the single crystal substrate and the solid layer" as recited in Applicant's Claims 31 and 34.

In paragraph 38 of the Response to Arguments section on page 15 of the

outstanding Office Action, the Examiner alleged, "both Itakura et al. and Nakahata et al. disclose boundary acoustic wave devices, as can be seen in figure 1 of Itakura et al. and at least figure 40 of Nakahata et al." This is absolutely incorrect and unsupported by any evidence of record.

As noted above, Itakura et al. and Nakahata et al. specifically disclose a **surface acoustic wave device** and fail to teach or suggest anything at all about a boundary acoustic wave device. For some unknown reason, contrary to the clear and explicit teachings of Itakura et al. and Nakahata et al., the Examiner continues to allege that Itakura et al. and Nakahata et al. teach boundary acoustic wave devices.

The Examiner appears to be under the erroneous impression that any acoustic wave device that includes a piezoelectric layer and another solid layer with an electrode disposed therebetween is necessarily a boundary acoustic wave device. This is clearly incorrect.

As the Examiner should be aware, a boundary acoustic wave device, by definition and as is well known by those of ordinary skill in the art, includes a piezoelectric substrate, a solid layer provided on the piezoelectric substrate and an electrode arranged at a boundary between the single crystal substrate and the solid layer, and constructed such that an acoustic energy is concentrated at the boundary between the single crystal substrate and the solid layer. Because no significant amount of energy is concentrated on the surface of either of the solid layers, a propagation of the boundary wave is not effected by a change in the surface condition of the solid layers. In order for the acoustic wave device including the structural elements described above to function as a boundary acoustic wave device, the thickness of the solid layer must be set to a specific value which enables the acoustic energy to be concentrated at the boundary between the single crystal substrate and the solid layer. With other thicknesses of the solid layer (usually smaller thicknesses), the acoustic wave device will function as a surface acoustic wave device, such as the devices of Itakura et al. and Nakahata et al., **not** as a boundary acoustic wave device.

Although Applicant respectfully disagrees with the prior art rejections of claims 23-28, 30, 31, and 33-57, in order to advance prosecution and more clearly define the boundary acoustic wave device of the present invention, as noted above, Applicant has amended Claims 31 and 34 to recite the feature of "properties of the boundary acoustic wave device are not changed by changes in surface conditions of the single crystal substrate and the solid layer."

Neither Itakura et al. nor Nakahata et al. teaches or suggests that the properties of the devices disclosed therein are not changed by changes in the surface conditions of the single crystal substrate and the solid layer. And in fact, since the devices disclosed in Itakura et al. and Nakahata et al. are **surface acoustic wave devices**, not boundary acoustic wave devices, the properties of the devices of each of Itakura et al. and Nakahata et al. would most certainly be changed by changes in the surface conditions of the single crystal substrate and the solid layer. Thus, Itakura et al. and Nakahata et al. certainly fail to teach or suggest the feature of "properties of the boundary acoustic wave device are not changed by changes in surface conditions of the single crystal substrate and the solid layer" as recited in Applicant's Claims 31 and 34.

Applicant respectfully requests that the Examiner explain where in Itakura et al. or Nakahata et al. a boundary acoustic wave device is disclosed, or where Itakura et al. or Nakahata et al. teaches or suggests that the devices disclosed therein function as boundary acoustic wave devices or excite any boundary acoustic waves.

In addition, the Examiner alleged that paragraphs 8 and 83 of Takayama et al. teach the feature of "a thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate" as recited in Applicant's Claims 31 and 34. However, paragraphs 8 and 83 of Takayama et al. disclose:

To overcome this problem, use of a substrate with a larger cut-angle is effective for substantial reduction of propagation loss. This idea is disclosed in Japanese Patent Application Non-Examined Publication No. H09-167936. According to this publication, the cut-angle of the substrate, which minimizes the propagation loss of the LSAW propagating on the LT single-crystal and LN single-crystal, varies in response to normalized film-thickness h/λ of the IDT electrode, where h=film thickness of the electrode, and λ=wavelength of the SAW. In the case of the LT single-crystal, when the film thickness of the IDT electrode becomes 0.03-0.15 of the wavelength of the LSAW (normalized film thickness h/.lambda. is 3%-15%), a shift of the cut-angle from 36° to 39°-46° can almost eliminate the propagation loss. In the same manner, in the case of the LN single-crystal, when the film thickness of the IDT electrode becomes 0.03-0.15 of the wavelength of the LSAW (normalized film thickness h/.lambda. is 3%-15%), a shift of the cut-angle from 64° to a greater angle, such as 66°-74°, can reduce the propagation loss to almost 0 (zero).

...

A saw resonator as comparison sample 1 has the following specifications: pitch "p" of finger-electrodes 301 is 1.06 μm, and normalized film thickness h/λ is 6.0%. Another SAW resonator as comparison sample 2 has the following specifications: pitch "p" of finger-electrodes 301 is 1.0 μm, and normalized film thickness h/λ is 11%. Those samples have resonance frequencies of 1886.0 MHz (comparison sample 1) and 1884.9 MHz (comparison sample 2). The acoustic velocities of those comparison samples can be found by equation (1) and with their resonance frequencies f, comparison sample 1 has an acoustic velocity of 3998.3 m/s, and comparison sample 2 has an acoustic velocity of 3769.8 m/s. Those velocities are faster than the phase velocity of the slow shear wave propagating on the 39° Y-XLT substrate used in this first embodiment. On top of that, both of those two comparison samples do not satisfy the relation of 2xp≤vb/f.

Neither these portions nor any other portion of Takayama et al. teach or suggest anything at all about an acoustic velocity of an **SH type boundary acoustic wave** relative to acoustic velocities of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate. In fact, as noted above, Takayama et al. is not even directed to a **boundary acoustic wave** device. Instead, Takayama et al. is

specifically and exclusively directed to a **surface acoustic wave** device, **NOT a boundary acoustic wave** device, and Takayama et al. neither teaches or suggests that the structure disclosed therein could or should be used for a boundary acoustic wave device.

At best, Takayama et al. merely teaches that the acoustic velocity of a leaky surface acoustic wave should be slower than a slow shear wave propagating on the substrate. Takayama et al. fails to teach or suggest any relationship whatsoever between the acoustic wave of the surface acoustic wave and the acoustic velocity of a slow shear wave propagating through a solid layer. In fact, since Takayama et al. teaches a surface acoustic wave device, not a boundary acoustic wave device, there would not be any slow shear wave propagating through a solid layer.

Thus, contrary to the Examiner's allegations, Takayama et al. clearly fails to teach or suggest the feature of "a thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate" as recited in Applicant's Claims 31 and 34.

In addition, even assuming *arguendo* that Takayama et al. taught or suggested this feature, Takayama et al. would still fail to teach or suggest an electrode density that is greater than 3,745 kg/m^3. The electrode used in the surface acoustic wave device of Takayama et al. is specifically disposed as being made of aluminum or a metal comprising primarily aluminum (see, for example, paragraph [0096] of Takayama et al.). Since the density, ρ, of aluminum is approximately 2700 kg/m^3, Takayama et al. clearly fails to teach or suggest the features of "H/λ>8261.744$\rho^{-1.376}$, when ρ (kg/m^3) represents the density of the electrodes, H represents the thickness of the electrodes, and λ represents the wavelength of a boundary wave" and "ρ>3,745 kg/m^3" as recited in Applicant's Claim 31.

In paragraph 40 in the Response to Arguments section on page 16 of the outstanding Office Action, the Examiner alleged, "a device may be both a surface acoustic wave device and a boundary acoustic wave device. The device of Itakura et al. generates a surface acoustic wave along the boundary between the zinc oxide layer and the silicon dioxide layer; therefore, the device of Itakura et al. is a boundary acoustic wave device." Applicant strongly disagrees.

Contrary to the Examiner's allegations, Itakura et al. fails to teach or suggest that the surface acoustic wave device of Itakura et al. could or should excite any boundary acoustic wave, and instead, Itakura et al. merely discloses that the surface acoustic wave device of Itakura et al. excites a surface acoustic wave. Applicant respectfully requests that the Examiner specifically point out where Itakura et al. teaches or suggests that the surface acoustic wave device of Itakura et al. is both a surface acoustic wave device and a boundary acoustic wave device, as alleged by the Examiner.

With respect to the feature of "$H > 8261.744\rho^{-1.376}$, when ρ (kg/m^3) represents the density of the electrodes, H (λ) represents the thickness of the electrodes, and λ represents the wavelength of a boundary wave" recited in Applicant's Claim 31, the Examiner alleged that Taniguchi teaches this feature because, "[t]he claim language does not define the wavelength or how to determine it; therefore, the wavelength can be any desired value. Therefore, the electrode thickness would meet the condition H $> 8261.744\rho^{-1.376}$." Applicant respectfully disagrees.

In paragraph 42 in the Response to Arguments section on pages 16 and 17 of the outstanding Office Action, the Examiner alleged, "the claim language does not contain any limitation directed to the characteristics of the IDT electrodes or the wavelength of the device; therefore, as the combination of Itakura et al., Taniguchi, and Takayama et al. discloses each of the claimed structural elements, the structure resulting from that combination would have the same properties."

Although Applicant respectfully disagrees with the Examiner's allegations, Applicant's Claim 31 has been amended to recite the feature of "$H/\lambda > 8261.744\rho^{-1.376}$, when ρ (kg/m^3) represents the density of the electrodes, H represents the thickness of the electrodes, and λ represents the wavelength of a boundary wave." Thus, Applicant's Claim 31, as amended, clearly recites a feature directed to the wavelength of the device.

Since Taniguchi fails to teach or suggest any specific thickness of the IDT electrodes, contrary to the Examiner's allegation, Taniguchi certainly fails to teach or suggest the feature of "$H/\lambda > 8261.744\rho^{-1.376}$, when ρ (kg/m^3) represents the density of the electrodes, H represents the thickness of the electrodes, and λ represents the wavelength of a boundary wave" as recited in Applicant's Claim 31.

With respect to Claim 34, the Examiner alleged that "it would have been obvious to a person of ordinary skill in the art to combine the crystal orientation of Nakahata with the boundary acoustic wave device of Itakura et al. as modified by Taniguchi and Takayama et al. for the benefit of an acoustic velocity of 8000 m/s or higher." However, the Examiner has failed to explain (1) why one of ordinary skill in the art would want the acoustic velocity of the surface acoustic wave device of Itakura et al. to be 8000 m/s or higher; and (2) what specific benefit would have been obtained if the acoustic velocity of the surface acoustic wave device of Itakura et al. was 8000 m/s or higher.

In summary, since none of Itakura et al., Taniguchi, Takayama et al., and Nakahata et al. teaches or suggests any boundary acoustic wave devices whatsoever, Itakura et al., Taniguchi, Takayama et al., and Nakahata et al. certainly fail to teach or suggest the unique combination and arrangement of features recited in Applicant's Claims 31 and 34.

The Examiner has again made baseless allegations that at least Itakura et al. and Nakahata et al. teach boundary acoustic wave device. However, these allegations are completely unsubstantiated by any teachings or suggestions in either of Itakura et al. or Nakahata et al or any other evidence whatsoever. Further, Itakura et al. and

Nakahata et al. clearly fail to teach or suggest the feature of "properties of the boundary acoustic wave device are not changed by changes in surface conditions of the single crystal substrate and the solid layer" as recited in Claims 31 and 34.

The Examiner is reminded that prior art rejections must be based on evidence. Graham v. John Deere Co., 383 U.S. 117 (1966). The Examiner is hereby requested to provide references to specific portions of Itakura et al. and Nakahata et al. or other evidence to support his position that Itakura et al. and Nakahata et al. teach or suggest boundary acoustic wave devices.

Accordingly, Applicant respectfully requests reconsideration and withdrawal of the rejection of Claim 31 under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi and Takayama et al., and the rejection of Claim 34 under 35 U.S.C. § 103(a) as being unpatentable over Itakura et al. in view of Taniguchi and Takayama et al., and further in view of Nakahata.

The Examiner relied upon Takamine, Nishiyama et al., Mishima et al., and Kadota et al. to allegedly cure various deficiencies of Itakura et al., Taniguchi, and Takayama et al. However, Takamine, Nishiyama et al., Mishima et al. and Kadota et al. fail to teach or suggest the features of "a thickness of the electrodes is set so that the acoustic velocity of an SH type boundary acoustic wave is lower than the acoustic velocity of a slow transverse wave propagating through the solid layer and the acoustic velocity of a slow transverse wave propagating through the piezoelectric single crystal substrate," "$H/\lambda > 8261.744\rho^{-1.376}$, when ρ (kg/m^3) represents the density of the electrodes, H represents the thickness of the electrodes, and λ represents the wavelength of a boundary wave," "$\rho > 3,745$ kg/m^3," and "the piezoelectric single crystal substrate is a LiNbO$_3$ substrate, ϕ of Euler angles (ϕ, θ, ψ) of the LiNbO$_3$ substrate is in the range of -31° to 31°, and θ and ψ are in the range surrounded by points A1 to A13 shown in the following Table 1" as recited in Applicant's Claims 31 and 34. Thus, Applicant respectfully submits that Takamine, Nishiyama et al., Mishima et al. and Kadota et al. fail to cure the deficiencies of Itakura et al., Taniguchi, Takayama et al.,

and Nakahata et al. described above.

Accordingly, Applicant respectfully submits that Itakura et al., Taniguchi, Takayama et al., Takamine, Nakahata et al., Nishiyama et al., Mishima et al. and Kadota et al., applied alone or in combination, fail to teach or suggest the unique combination and arrangement of features recited in Applicant's Claims 31 and 34.

In view of the foregoing amendments and remarks, Applicant respectfully submits that Claims 31 and 34 are allowable. Claims 23-28, 30, 33, and 36-57 depend upon Claims 31 and 34, and are therefore allowable for at least the reasons that Claims 31 and 34 are allowable.

In view of the foregoing amendments and remarks, Applicant respectfully submits that this application is in condition for allowance. Favorable consideration and prompt allowance are solicited.

The Commissioner is authorized to charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account No. 50-1353.

Respectfully submitted,

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